

INTERIM RESULTS

**Analysis of
California Phase 3 RFG**

submitted to

California Energy Commission

under

Subcontract No. LB60100

by

MathPro Inc.

P.O. Box 34404
West Bethesda, Maryland 20827-0404
301-951-9006

November 22, 1999

Refinery Modeling -- Cases and Assumptions

Base Cases

- Base 98. Calibrated to 1998, using the Phase 2 Predictive Model *with observed property compliance margins and observed emissions deltas*.
- Base 1. Same as Base 98, but requires Arizona gasoline to comply with Federal Phase 2 RFG standards. This serves as the base case for calculating the costs associated with the MTBE ban and adoption of the Phase 3 Predictive Model (with different variants of reference fuels).
- Base 2. Same as Base 1 with the following exceptions: (1) uses the Phase 3 Predictive Model with Reference Fuel A; and (2) uses the emissions deltas specified in Version 13 of the Matrix (i.e., does not use compliance margins, but instead uses large emission deltas calculated by running the 1998 reported fuel recipe through the Phase 3 Predictive Model).

MTBE Ban Cases

- Case 1a. Uses (1) the Phase 3 Predictive Model with Reference Fuel A and (2) the same emissions deltas as specified for Base 2.
- Case 2a. Uses (1) the Phase 3 Predictive Model with Reference Fuel B (ARB's proposed reference fuel) and (2) property compliance margins and emissions deltas specified by ARB.
- Case 3a. Uses (1) the Phase 3 Predictive Model with Reference Fuel C (less stringent T50 and T90 specifications) and (2) property compliance margins and emissions deltas specified by ARB.
- Case 4a. Uses (1) the Phase 3 Predictive Model with Reference Fuel D (Reference Fuel B with 7.0 psi RVP) and (2) property compliance margins and emissions deltas specified by ARB.
- Sup 1a. Uses (1) the *Phase 2 Predictive Model* and (2) property compliance margins and emissions deltas specified by ARB. This case was not specified in the Version 13 Matrix, but we included it to allow a comparison to results in the previous study.

Key Modeling Assumptions

We used the refinery model and boundary conditions specified in the “long term” analysis in the previous study for CEC of the effects of an MTBE ban, with the following exceptions.

- Ethanol supply curve. The price paid for ethanol (ex subsidy) is \$43.55/bbl as compared to \$28.98 (reflecting EIA’s recent updates of the ethanol supply function for CEC).
- Ethanol blending: ethanol is blended at 2.0 wt% oxygen as opposed to 2.7 wt% oxygen.
- Arizona and conventional gasoline. Arizona gasoline is ethanol-blended (2.0 wt%) and conventional gasoline contains no oxygen. In the previous study, MTBE and TAME were blended in Arizona and conventional gasoline (except in the national MTBE ban cases).
- Alkylate supply. We assumed that refiners would buy C7 alkylate, rather than mixed alkylate, because of the value to California refiners of blendstocks with low T50. We increased the price of purchased alkylate by 7¢/gal to account for (1) the potential effects of EPA’s gasoline sulfur standard on the market price of alkylate and (2) costs that might be incurred to fractionate alkylate into light and heavy cuts.
- CARBOB supply. We increased the price of CARBOB by 2¢/gal (CARBOB was not imported in the cases consider in this round of analysis).
- Desulfurization: We added fractionation and post-FCC treatment of naphthas produced from ultra-low sulfur FCC feeds. (We assumed OCTGAIN 125 would be used.) We assumed that alkylate, hydrocrackate, and reformate would have sulfur content of 2, 1, and 1 ppm, respectively, for Cases 2a, 3a, and 4a (those cases in which the reference fuel has a sulfur level of 20 ppm). We accounted for the cost of controlling the sulfur content of those blendstocks by (1) reducing “existing” alkylate capacity by 5% and (2) adding additional investment, capital charges, and operating costs in post-modeling spreadsheet processing.

The estimated per gallon costs shown in Exhibit 6 are calculated by dividing total costs by the volume of California RFG, even though Arizona gasoline is ethanol-blended and conventional gasoline is assumed to contain no oxygenates. This is consistent with calculations in the previous study (except where a national MTBE ban was considered).

California Phase 3 RFG -- INTERIM RESULTS

**Exhibit 1: Process Unit Utilization, Additions, and Operations
(K bbl/d)**

Type of Process	Process	Phase 2 PM		Phase 3 PM					PM-2
		MTBE		Ethanol (2.0 wt%)					
		RF A Delta Obs	RFA Delta Obs	RF A	RF A Delta ARB	RF B Delta ARB	RF C Delta ARB	RF D Delta ARB	RF A Delta ARB
Case Name-->	Base 98	Base 1	Base 2	Case 1a	Case 2a	Case 3a	Case 4a	Sup 1a	
USE OF EXISTING CAPACITY									
Crude Distillation	Atmospheric	1,992	1,990	1,993	2,001	2,006	1,997	2,015	1,995
Conversion	Fluid Cat Cracker	721	720	721	725	727	723	730	722
	Hydrocracker - Distillate Feed	284	284	284	291	291	287	291	289
	Hydrocracker - Gas Oil Feed	143	143	143	143	143	143	143	143
	Coking - Delayed	385	384	385	386	387	386	390	385
	Coking - Fluid & Flexi	106	106	106	106	106	106	106	106
Upgrading	Alkylation	163	166	162	172	161	161	161	172
	Dimersol	1		1	5	5	6	4	4
	Pen/Hex Isomerization	68	68	68	58	68	4	58	62
	Polymerization	5	5	5	6	6	66	6	6
	Reforming (150-350 psi)	344	344	347	374	377	377	382	372
Oxygenate Prod.	MTBE Plant	12	12	12					
	Tame Plant	2	2	2					
Hydrotreating	Naphtha & Isom Feed Desulf.	74	74	82	61	65	76	63	83
	Reformer Feed Desulfurization	287	288	299	286	282	287	291	270
	Distillate Desulfurization	355	358	357	373	374	364	375	372
	Distillate Dearomatization	113	112	111	109	109	113	108	110
	FCC Feed Desulf. -- Conv.	344	344	344	346	347	345	349	345
	FCC Feed Desulf. -- Deep	373	372	373	375	376	374	378	373
	FCC Naphtha Hydrotreater	101	97	101	90	101	101	101	101
Hydrogen (foeb)	Benzene Saturation	66	66	66	66	66	66	66	66
Other	Hydrogen Plant (foeb)	1,309	1,312	1,311	1,310	1,321	1,327	1,322	1,304
Fractionation	Butane Isomerization	18	18	18	18	18	18	18	18
	Lubes & Waxes	25	25	25	25	25	25	25	25
	Solvent Deasphalting	50	50	50	50	50	50	50	50
	Sulfur Recovery (tons/d)	5,990	5,986	5,996	6,000	6,000	6,000	6,000	6,000
	Debutanization	196	197	197	197	197	197	197	197
Upgrading	Depentanization	64	64	64	64	64	64	64	64
	Lt. Naphtha Spl. (Benz. Prec.)	112	114	109	114	114	114	114	114
	FCC Naphtha Splitter	178	178	178	178	178	178	178	178
	FCC Naphtha T90 Control	29	29	23	29	29	29	29	29
NEW CAPACITY									
Upgrading	Alkylation			0	19	11	12		
	Pen/Hex Isomerization								
	Polymerization								
Hydrotreating	FCC Naphtha Hydrotreater				26	21	2		
	Benzene Saturation			5	11		7		
Hydrogen (foeb)	Hydrogen Plant (foeb)								
Other	Butane Isomerization								
	Propane Dehydrogenation								
	FCC Gas Processing			1	14				
	Sulfur Recovery (tons/d)			26	43	12	79	3	
Fractionation	Debutanization		0	23	21	20	23	20	
	Depentanization			128	106	22	54	49	
	Lt. Naphtha Spl. (Benz. Prec.)			94	89	94	98	77	
	Naphtha Splitter (T90 Control)								
	Heavy Reformate Splitter								
	FCC Naphtha Splitter	0		119	130	85	122	118	
	FCC Naphtha (T90 Control)	0	26	231	243	195	232	227	
OPERATIONS									
Operating Indices	FCC Conversion (Vol %)	71	71	70	75	73	74	74	74
	Reformer Severity (RON)	100	100	100	100	100	100	100	100
Charge Rates	Fluid Cat Cracker	721	720	721	725	727	723	730	722
	Reformer (150-350 psi)	344	344	348	374	377	377	382	372
FCC Olefin Max Cat. (%)				0	2				

Exhibit 2A: Refinery Inputs
(K barrels/day)

Inputs	Phase 2 PM		Phase 3 PM					PM-2
	MTBE		Ethanol (2.0 wt%)					
	RF A	RFA	RF A	RF A	RF B	RF C	RF D	RFA
	Delta Obs	Delta Obs			Delta ARB	Delta ARB	Delta ARB	Delta ARB
Inputs	Base 98	Base 1	Base 2	Case 1a	Case 2a	Case 3a	Case 4a	Sup 1a
Crude Oil	1,992	1,990	1,993	2,000	2,005	1,996	2,014	1,994
Specified Inputs	68	68	68	68	68	68	68	68
Propylene Alkylate	6	6	6	6	6	6	6	6
Butylene Alkylate	6	6	6	6	6	6	6	6
Heavy Gas Oils	19	19	19	19	19	19	19	19
Residuum	38	38	38	38	38	38	38	38
Isobutane	0	3	0	0	5	0	0	1
P1		3			5			1
P2								
Isomerate	0	0	0	13	19	0	10	15
P1				10	10		10	10
P2				3	9			5
P3								
C7 Alkylate	0	0	0	100	100	100	100	100
P1				16	16	16	16	16
P2				22	22	22	22	22
P3				62	62	62	62	62
MTBE	107	107	107	0	0	0	0	0
P1	31	31	31					
P2	60	60	60					
P3	16	16	16					
Ethanol	0	0	0	63	63	63	63	63
P1				59	59	59	59	59
P2				4	4	4	4	4
P3								
CARBOB	0	0	0	0	0	0	0	0
P1								
P2								
P3								
Methanol	5	5	5					
Distillate Blendstocks								
Jet Fuel								
EPA Diesel								
Purchased Energy								
Electricity (K Kwh)	16,359	16,401	16,448	17,191	17,383	17,315	17,331	17,076
Fuel (foeb)	193	193	193	181	184	184	184	182

Exhibit 2B: Prices of Refinery Inputs
(\$ per barrel)

Inputs	Phase 2 PM		Phase 3 PM					PM-2
	MTBE		Ethanol (2.0 wt%)					
	RF A	RFA	RF A	RF A	RF B	RF C	RF D	RFA
	Delta Obs	Delta Obs			Delta ARB	Delta ARB	Delta ARB	Delta ARB
Inputs	Base 98	Base 1	Base 2	Case 1a	Case 2a	Case 3a	Case 4a	Sup 1a
Isobutane								
P1	22.19	22.19	22.19	22.19	22.19	22.19	22.19	22.19
P2	24.36	24.36	24.36	24.36	24.36	24.36	24.36	24.36
Isomerate								
P1	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00
P2	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00
P3	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00
C7 Alkylate								
P1	32.34	32.34	32.34	35.28	35.28	35.28	35.28	35.28
P2	32.92	32.92	32.92	35.86	35.86	35.86	35.86	35.86
P3	34.23	34.23	34.23	37.17	37.17	37.17	37.17	37.17
MTBE								
P1	31.92	31.92	31.92	31.92	31.92	31.92	31.92	31.92
P2	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86
P3	39.06	39.06	39.06	39.06	39.06	39.06	39.06	39.06
Ethanol								
P1				40.24	40.24	40.24	40.24	40.24
P2				43.55	43.55	43.55	43.55	43.55
P3				50.40	50.40	50.40	50.40	50.40
CARBOB								
P1	29.74	29.74	29.74	29.74	29.74	29.74	29.74	29.74
P2	29.90	29.90	29.90	29.90	29.90	29.90	29.90	29.90
P3	31.32	31.32	31.32	31.32	31.32	31.32	31.32	31.32
Methanol	28.56	28.56	28.56	28.56	28.56	28.56	28.56	28.56
Distillate Blendstocks	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50
Jet Fuel	26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.50
EPA Diesel	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00

Exhibit 2C: Availability of Refinery Inputs, by Case
(K bbl/d)

Inputs	Phase 2 PM		Phase 3 PM					PM-2
	MTBE		Ethanol (2.0 wt%)					
	RF A	RFA	RF A	RF A	RF B	RF C	RF D	RFA
	Delta Obs	Delta Obs			Delta ARB	Delta ARB	Delta ARB	Delta ARB
Inputs	Base 98	Base 1	Base 2	Case 1a	Case 2a	Case 3a	Case 4a	Sup 1a
Isobutane								
P1	12	12	12	12	12	12	12	12
P2								
Isomerate								
P1	10	10	10	10	10	10	10	10
P2	10	10	10	10	10	10	10	10
P3	10	10	10	10	10	10	10	10
C7 Alkylate								
P1	16	16	16	16	16	16	16	16
P2	22	22	22	22	22	22	22	22
P3	62	62	62	62	62	62	62	62
MTBE								
P1	31	31	31	31	31	31	31	31
P2	60	60	60	60	60	60	60	60
P3								
Ethanol								
P1				59	59	59	59	59
P2				27	27	27	27	27
P3								
CARBOB								
P1	130	130	130	130	130	130	130	130
P2	26	26	26	26	26	26	26	26
P3	44	44	44	44	44	44	44	44
Methanol								
Distillate Blendstocks								
Jet Fuel								
EPA Diesel								

Exhibit 2D: Cost Adjustment for Blendstock and Refined Product Supply Curves
(\$K/day)

Inputs	Phase 2 PM		Phase 3 PM					PM-2
	MTBE		Ethanol (2.0 wt%)					
	RF A Delta Obs	RFA Delta Obs	RF A	RF A	RF B Delta ARB	RF C Delta ARB	RF D Delta ARB	RF A Delta ARB
	Base 98	Base 1	Base 2	Case 1a	Case 2a	Case 3a	Case 4a	Sup 1a
Isobutane								
ARMS Cost	0	55	0	0	116	0	0	33
Market Cost	0	55	0	0	116	0	0	33
Adjustment	0	0	0	0	0	0	0	0
Isomerate								
ARMS Cost	0	0	0	350	515	0	260	385
Market Cost	0	0	0	360	525	0	260	395
Adjustment	0	0	0	10	10	0	0	10
C7 Alkylate								
ARMS Cost	0	0	0	3,658	3,658	3,658	3,658	3,658
Market Cost	0	0	0	3,717	3,717	3,717	3,717	3,717
Adjustment	0	0	0	59	59	59	59	59
MTBE								
ARMS Cost	3,710	3,710	3,710	0	0	0	0	0
Market Cost	4,184	4,184	4,184	0	0	0	0	0
Adjustment	473	473	473	0	0	0	0	0
Ethanol								
ARMS Cost	0	0	0	2,533	2,533	2,533	2,533	2,533
Market Cost	0	0	0	2,728	2,728	2,728	2,728	2,728
Adjustment	0	0	0	195	195	195	195	195
CARBOB								
ARMS Cost	0	0	0	0	0	0	0	0
Market Cost	0	0	0	0	0	0	0	0
Adjustment	0	0	0	0	0	0	0	0
Total Adjustment	473	473	473	264	264	254	254	264

Exhibit 3: Refined Product Outputs and Sales of Rejected Blendstocks
(K barrels/day)

Outputs	Phase 2 PM		Phase 3 PM				PM-2	
	MTBE		Ethanol (2.0 wt%)					
	RF A Delta Obs	RFA Delta Obs	RFA	RF A	RF B Delta ARB	RF C Delta ARB	RF D Delta ARB	RF A Delta ARB
	Base 98	Base 1	Base 2	Case 1a	Case 2a	Case 3a	Case 4a	Sup 1a
REFINED PRODUCTS*	2,237	2,237	2,237	2,243	2,256	2,236	2,252	2,250
Propane	37	37	37	37	37	37	37	37
Propylene	2	2	2	2	2	2	2	2
Butane	30	30	30	30	30	30	30	30
Mixed Butylenes	4	4	4	4	4	4	4	4
Naphtha	3	3	3	3	3	3	3	3
Gasoline:								
California RFG	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022
Arizona RFG	68	68	68	68	68	68	68	68
Conventional	161	161	161	161	161	161	161	161
Aviation Gasoline	5	5	5	5	5	5	5	5
Jet Fuel	333	333	333	333	333	333	333	333
Diesel Fuel:								
CARB Diesel	204	204	204	204	204	204	204	204
EPA Diesel	122	122	122	122	122	122	122	122
Other	18	18	18	18	18	18	18	18
Lubes & Waxes	25	25	25	25	25	25	25	25
Residual Fuel Oil	58	58	58	64	77	57	72	71
Asphalt								
Coke	144	144	145	145	145	145	146	145
Sulfur (K tons/d)	6	6	6	6	6	6	6	6
REJECTED BLENDSTOCKS	0	0	0	47	49	39	49	37
Mixed Butylenes				5	1	5	5	4
Pentanes				28	27	9	18	11
Light Coker Naphtha								
Light FCC Gasoline				13	20	25	25	21
Heavy FCC Gasoline								
Naphtha (250 - 325 °F)								
Heavy Reformate								
TOTAL	2,237	2,237	2,237	2,290	2,305	2,275	2,301	2,287

* Excludes Sulfur

Exhibit 4: Gasoline Properties

Property & Predictive Model % Emissions	Phase 2 PM						Phase 3 PM		
	MTBE								
	RF A Delta Obs			RF A Delta Obs			RF A		
	Base 98			Base 1			Base 2		
	CARB	Ariz.	Conv.	CARB	Ariz.	Conv.	CARB	Ariz.	Conv.
Property									
RVP (psi)	6.8	6.7	8.1	6.8	6.6	8.1	6.7	6.6	8.1
Oxygen (wt%)	2.0	2.0	0.1	2.0	2.0	0.1	2.0	2.0	0.1
Aromatics (vol%)	24.2	28.0	34.4	24.4	21.1	34.4	24.8	24.0	34.4
Benzene (vol%)	0.60	0.65	0.65	0.58	0.65	0.65	0.54	0.65	0.65
Olefins (vol%)	4.1	5.2	10.0	4.1	5.2	10.0	4.3	5.2	10.0
Sulfur (ppm)	21.8	35.0	90.0	21.8	35.0	90.0	20.9	35.0	90.0
E200 (vol% off)	49.5	43.0	38.9	49.6	43.0	38.9	48.9	44.8	38.9
E300 (vol% off)	87.4	76.2	78.5	87.1	84.4	78.5	86.2	84.4	78.5
T10 (1)	134	137	140	134	136	136	134	135	135
T50 (2)	201	219	229	201	219	229	203	214	229
T90 (3)	307	339	333	308	316	333	311	316	333
Estimated DI	1112	1200	1230	1113	1175	1225	1121	1160	1223
En. Den. (MM Btu/bbl)	5.138	5.213	5.277	5.144	5.152	5.257	5.152	5.169	5.248
Predictive Model % Emissions (4)									
VOCs	-0.93			-0.87			-3.56		
NOx	-0.36			-0.41			-3.94		
Toxics	5.00			-0.75			-11.61		

(1) Linear interpolations from ARMS generated distillation curves.

(2) Calculated using formula: $T50 = (125.3846 - E200)/0.3769$.(3) Calculated using formula: $T90 = (196.1538 - E300)/0.3538$.

(4) % emissions are calculated by adding "Property Compliance Margins" (observed and specified by ARB) to the gasoline properties shown above.

Exhibit 4: Gasoline Properties

Property & Predictive Model % Emissions	Phase 3 PM												Phase 2 PM		
	Ethanol (2.0 wt%)														
	RF A			RF B			RF C			RF D			RF A		
	Delta ARB			Delta ARB			Delta ARB			Delta ARB			Delta ARB		
	Case 1a			Case 2a			Case 3a			Case 4a			Sup 1a		
	CARB	Ariz.	Conv.	CARB	Ariz.	Conv.	CARB	Ariz.	Conv.	CARB	Ariz.	Conv.	CARB	Ariz.	Conv.
Property															
RVP (psi)	6.6	6.6	8.1	6.6	6.6	8.1	6.6	6.6	8.1	6.6	6.6	8.1	6.8	6.6	8.1
Oxygen (wt%)	2.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Aromatics (vol%)	24.6	18.0	34.4	24.2	18.0	34.4	25.0	18.0	34.4	24.8	18.0	34.4	24.1	18.0	34.4
Benzene (vol%)	0.53	0.65	0.65	0.55	0.65	0.65	0.55	0.65	0.65	0.50	0.65	0.65	0.71	0.65	0.65
Olefins (vol%)	4.4	5.2	10.0	3.3	5.2	10.0	3.3	5.2	10.0	3.4	5.2	10.0	3.4	5.2	10.0
Sulfur (ppm)	20.3	35.0	90.0	10.4	35.0	90.0	14.0	35.0	90.0	14.4	35.0	90.0	17.9	35.0	90.0
E200 (vol% off)	46.8	43.0	38.9	47.0	43.0	38.9	46.2	43.0	38.9	46.6	43.0	38.9	48.0	43.0	38.9
E300 (vol% off)	88.4	82.0	78.5	89.0	82.0	78.5	88.2	82.0	78.5	88.4	82.0	78.5	88.7	82.0	78.5
T10 (1)	132	130	140	132	129	138	132	130	138	133	130	138	131	135	140
T50 (2)	208	219	229	208	219	229	210	219	229	209	219	229	205	219	229
T90 (3)	305	323	333	303	323	333	305	323	333	305	323	333	304	323	333
Estimated DI	1129	1174	1231	1125	1172	1228	1134	1173	1228	1131	1173	1228	1117	1181	1231
En. Den. (MM Btu/bbl)	5.131	5.092	5.276	5.121	5.113	5.281	5.131	5.106	5.287	5.129	5.100	5.287	5.118	5.128	5.292
Predictive Model % Emissions (4)															
VOCs	-3.64			-0.12			-0.13			-0.11			-0.11		
NOx	-3.96			-0.96			-0.22			-0.20			-0.84		
Toxics	-11.84			-0.23			-0.23			-0.24			-0.25		

(1) Linear interpolations from ARMS generated distillation curves.

(2) Calculated using formula: $T50 = (125.3846 - E200)/0.3769$.(3) Calculated using formula: $T90 = (196.1538 - E300)/0.3538$.

(4) % emissions are calculated by adding "Property Compliance Margins" (observed and specified by ARB) to the gasoline properties shown above.

Exhibit 5: Gasoline Composition and Volume

Gasoline Composition & Volume	Phase 2 PM								Phase 3 PM							
	MTBE															
	RF A				RF A				RF A							
	Delta Obs				Delta Obs											
	Base 98				Base 1				Base 2							
	CARB	Ariz.	Conv.	Pool	CARB	Ariz.	Conv.	Pool	CARB	Ariz.	Conv.	Pool	CARB	Ariz.	Conv.	Pool
Composition (vol%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
C4s:	0.6	2.0	4.5	1.2	0.9	1.3	3.3	1.2	0.5	1.0	5.0	1.1				
Butenes																
I-Butane																
N-Butane	0.6	2.0	4.5	1.2	0.9	1.3	3.3	1.2	0.5	1.0	5.0	1.1				
C5s & Isomerate	6.4	0.5	2.7	5.7	4.2	9.2	13.3	5.7	3.1	6.5	21.2	5.7				
Raffinate																
Natural Gas Liquids																
Naphtha	2.5	0.0	4.8	2.7	2.4	1.5	4.8	2.7	3.2	0.0	0.0	2.7				
C5-160	2.5		4.8	2.7	2.4	1.5	4.8	2.7	3.2			2.7				
Coker Naphtha																
160-250																
Alkylate	14.2	9.0	9.2	13.4	14.9	17.5	2.9	13.7	14.9	16.4	1.0	13.4				
Hydrocrackate	17.3	5.1	0.0	14.6	17.6	2.8		14.7	17.2	5.3	0.1	14.5				
Dimate																
Poly Gasoline	0.1			0.1					0.1	0.2	0.0	0.1				
FCC Gasoline:	25.6	59.3	50.5	29.8	27.6	44.8	41.5	29.5	28.6	34.9	41.8	29.8				
Full Range	17.3	29.0	6.6	16.7	20.0			16.6	20.2			16.7				
Light	1.9	0.4	0.4	1.7	1.8	0.9	1.1	1.7	2.0			1.7				
Light - Desulf.	0.6	3.3	4.4		0.6	7.0	2.5		0.6	13.4						
Medium	1.6		23.6	4.4	1.1	2.9	26.9	4.6	0.3	7.2	29.2	4.5				
Medum - Desulf.	2.7	14.9		3.0	2.2	19.2		2.9	3.0	9.8		3.0				
Heavy																
Heavy - Desulf.	1.5	11.7	15.5	3.9	1.9	14.8	11.0	3.8	2.5	4.5	12.6	4.0				
Reformate	22.3	13.0	27.6	22.7	21.4	11.9	33.7	22.7	21.4	24.5	30.2	23.0				
Light	8.6	7.2	22.5	10.5	9.5	11.9	13.6	10.3	9.5		13.9	9.6				
Medium																
Heavy	13.7	5.8	5.0	12.3	11.9		20.2	12.5	11.9	24.5	16.3	13.3				
Oxygenate	11.0	11.1	0.6	9.8	11.0	11.0	0.5	9.8	11.0	11.1	0.6	9.8				
MTBE	11.0	10.0		9.6	10.8	11.0	0.5	9.6	11.0	10.0		9.6				
Ethanol																
TBA																
ETBE																
TAME		1.1	0.6	0.1	0.2			0.1		1.1	0.6	0.1				
DIPE																
Volume (K Bbl/day)	1,022	68	161	1,236	1,022	68	161	1,236	1,022	68	161	1,236				

Exhibit 5: Gasoline Composition and Volume

Gasoline Composition & Volume	Phase 3 PM																PM-2					
	Ethanol (2.0 wt%)																					
	RF A				RF B Delta ARB				RF C Delta ARB				RF D Delta ARB				RF A Delta ARB					
	Case 1a				Case 2a				Case 3a				Case 4a				Sup 1a					
	CARB	Ariz.	Conv.	Pool																		
Composition (vol%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
C4s:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Butenes																						
1-Butane																						
N-Butane	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
C5s & Isomerate	6.7		2.9	5.8	7.2		9.4	7.1	5.0	4.5	7.9	5.3	5.5			7.4	5.5	7.2		2.5	6.2	
Raffinate																						
Natural Gas Liquids																						
Naphtha	2.6	1.5	0.0	2.2	1.9	2.4	0.0	1.7	3.2	2.7	0.0	2.8	3.0	0.0	1.7	2.7	2.6	24.2	4.9	4.1		
C5-160	2.5			2.0	1.4			1.1	3.2			2.6	3.0			1.7	2.7	1.2	18.2	4.9	2.6	
Coker Naphtha																						
160-250	0.1	1.5		0.2	0.5	2.4		0.6		2.7		0.1						1.4	6.0		1.4	
Alkylate	23.1	33.1	10.8	22.0	24.7	30.6	4.7	22.5	23.6	31.7	6.8	21.9	24.1	29.6	5.6	22.0	23.4	35.5	7.5	22.0		
Hydrocrackate	12.7	24.4	3.6	12.1	12.2	21.9	4.3	11.7	13.7	12.6	5.2	12.5	12.8	21.1	4.5	12.2	12.7		3.7	10.8		
Dimate																						
Poly Gasoline	0.5	0.7		0.5	0.5	0.9		0.5	0.5			0.4	0.5			0.4	0.5	0.6		0.4		
FCC Gasoline:	24.2	24.9	50.4	27.6	24.1	30.9	41.6	26.7	24.4	38.6	40.4	27.2	24.4	36.5	40.2	27.0	24.9	22.0	42.1	27.0		
Full Range	7.0		8.5	6.8	6.0	13.6		5.7	7.2	26.4	19.5	9.8	7.6			5.9	7.0	7.2		7.4	6.8	
Light	1.3	2.9	19.0	3.7	1.2		18.9	3.5	0.6		16.4	2.6	0.7	2.6	18.3	3.1	0.8	3.0	18.7	3.3		
Light - Desulf.																						
Medium	9.3	5.4	7.3	8.8	6.8	6.6	16.5	8.1	7.2	4.8	1.8	6.4	7.1	7.4	11.7	7.7	7.6	6.0	10.0	7.8		
Medium - Desulf.	4.8			3.9	6.1			5.0	5.7			4.7	5.3	10.1			4.9	5.8			4.7	
Heavy							6.1	0.8			1.1	0.1	2.0		4.3	2.2	1.3	7.1	6.0	2.2		
Heavy - Desulf.	1.9	12.8		2.2	3.9	10.8		3.7	3.7	7.4	1.7	3.7	1.6	16.3		2.2	2.2	6.0		2.2		
Reformate	23.9	9.3	31.9	24.2	23.1	7.0	39.6	24.3	23.4	3.7	39.2	24.4	23.5	6.6	40.2	24.7	22.5	11.4	38.8	24.0		
Light	9.0	9.3	27.5	11.4	12.6	5.2	7.6	11.5	11.6	2.2	12.4	11.2	12.6	6.6	7.6	11.7	11.9	4.3	11.6	11.4		
Medium																						
Heavy	14.9		4.4	12.8	10.5	1.8	32.1	12.8	11.7	1.5	26.8	13.1	10.8		32.6	13.0	10.6	7.1	27.2	12.6		
Oxygenate	5.7	5.7	0.0	5.0	5.7	5.7	0.0	5.0	5.7	5.7	0.0	5.0	5.7	5.7	0.0	5.0	5.7	5.7	0.0	5.0		
MTBE																						
Ethanol	5.7	5.7		5.0	5.7	5.7		5.0	5.7	5.7		5.0	5.7	5.7		5.0	5.7	5.7		5.0		
TBA																						
ETBE																						
TAME																						
DIPE																						
Volume (K Bbl/day)	1,022	68	161	1,251	1,022	68	161	1,251	1,022	68	161	1,251	1,022	68	161	1,251	1,022	68	161	1,251		

California Phase 3 RFG --INTERIM RESULTS

Exhibit 6: Estimated Costs of California Phase 3 RFG, by Case

Measure	Phase 3 PM						PM-2
	MTBE	Ethanol (2.0 wt%)					RF A Delta ARB
		RFA	RFA	RF B Delta ARB	RFC Delta ARB	RF D Delta ARB	
	Base 2	Case 1a	Case 2a	Case 3a	Case 4a	Sup 1a	
COSTS							
Total Average Cost (¢/gal.)	-0.2	5.5	6.4	5.2	5.7	5.1	
Variable Cost	0.0	4.2	4.6	3.8	4.2	3.9	
Refinery Capital Charge	0.0	0.7	1.1	0.8	0.9	0.4	
Ancillary Refining Cost		0.3	0.3	0.3	0.3	0.3	
Logistics Cost		0.1	0.1	0.1	0.1	0.1	
Mileage Loss	-0.1	0.2	0.4	0.2	0.3	0.5	
Total Seasonal Cost (\$ million)	-10	430	510	410	450	410	
Variable Cost	0	330	360	300	330	310	
Refinery Capital Charge	0	50	90	60	70	30	
Ancillary Refining Cost		20	20	20	20	20	
Logistics Cost		10	10	10	10	10	
Mileage Loss	-10	20	30	20	20	40	
Refinery Investment (\$million)	0	348	564	411	442	183	
IMPORTS/EXPORTS (K bbl/d)							
Oxygenates	107	63	63	63	63	63	63
MTBE	107						
Ethanol		63	63	63	63	63	
Other Imports	11	111	117	111	111	111	113
Isobutane			5				1
Alkylate	11	111	111	111	111	111	111
CARBOB							
Jet Fuel & EPA Diesel							
Rejected Blendstocks	0	47	49	39	49	37	
Mixed Butylenes		5	1	5	5	4	
Pentanes		28	27	9	18	11	
Light Coker Naphtha							
Light FCC Gasoline		13	20	25	25	21	
Heavy FCC Gasoline							
Naphtha (250 - 325 °F)							
Heavy Reformate							
CAPACITY UTILIZATION (%)							
Crude Distillation	98	99	99	99	99	98	
Conversion	97	97	98	97	98	97	
Upgrading	85	90	93	91	91	90	